A pilot study of quantification in child Catalan

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1 Background

The study of quantification in child language traces back to Inhelder and Piaget's (1964) work, when they found that children incurred a non-adult-like interpretation of universal quantification, with what was termed *over-exhaustive search*: up to the age of six or seven, children would answer *no* to

stood the question above as asking if all the circles are all the blue things.

Another error in the child interpretation of universal quantifiers reported in the literature is that of *underexhaustive search*. In this case, suppose we have a set of circles, one of which is red; then the proposition *All the circles are blue* is false; if the child considers the proposition true, discarting the falsifying instance, we have underexhaustive search.

There is a considerable literature on the occurrence of such errors in the course of language acquisition, and its theoretical interpretation (see Drozd, 2001; Drozd et al., in prep. for a summary and references). The pilot study reported here is mainly directed at finding out facts of the interpretation of the universal quantifier *tots* in Catalan for children aged 3 to 7.

The paper proceeds as follows: in Section 2, we sketch the properties of quantification in the target language, adult Catalan; in Section 3, we describe the experiment; in Section 4, we present the results and we discuss them in Section 5.[1]

1 We acknowledge the direction, teachers and children of the *Escola Decroly de Barcelona* for their kind collaboration in this experiment. We would also like to thank our first experimenters Carlota Faixa and Lena Morrill, and Bill Philip for kindly sharing with us

2 A sketch of quantification in Catalan

Although Catalan presents two universal quantifier, *cada* 'each' and *tots* 'all', their use is different from that found in other languages such as English and Spanish, to mention two languages for which studies on child quantification are available. Thus while (1a) is wellformed, (1b) is marginal out of context – in contrast with its English translation.

(1a) Tots els nens van portar berenar.
All the children PAST bring tea
'All the children brought tea.'
(1b) ?Cada nen va portar berenar.
Each child PAST bring tea
'Each child brought tea.'

Cada is found when an element requiring binding appears in the immediate context, as in (2).

(2) Cada nen_i ha de portar el seu_i berenar.
each child has to bring the his tea

The peculiar distribution of *cada* in adult Catalan led us to design our experiment only with the quantifier *tots*, exemplified in (1a). *Tots* is a non-intrinsic universal quantifier, which allows a distributional and a collective interpretation in Catalan, as shown in (3), from Brucart and Rigau (2002):

(3) Tots els estudiants seran rebuts pel degà.
all the students be-FUT received by-the dean
(i) 'The dean will receive the students one by one.'
(ii) 'The dean will receive all the students together.'

Morphologically, *tots* is inflected for number and gender; thus its full paradigm is *tot* (masc., sg.), *tota* (fem., sg.), *tots* (masc., pl.), *totes* (fem., pl.). Syntactically, it adjoins to definite DPs to give projections of the same type; see the need for a definite DP by comparing (3) above with (4).

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(4) *Tots estudiants seran rebuts pel degà.
all students be-FUT received by-the dean

In fact, all determiners appear after *tots*, as in (5) (for this and further details on *tots*, see Brucart and Rigau, 2002).

(5) *Quatre tots / Tots quatre estudiants es van presentar
Four all all four students CLPAST present
a l' examen.
to the exam
'All four students sat the exam.'

Finally, the distribution of quantifiers in the adult grammar displays asymmetries between subject and object position in Catalan, as illustrated in (7) for *cada*, to be compared to (6) for English *each*.

(6a) Each mother saw a child.
(6b) A mother saw each child.

(7a) Cada nen va portar-se el berenar.
each child PAST bring-CL the tea
'Each child brought his tea.'
(7b) *El nen va portar-se cada berenar.
the child PAST bring-CL each tea
(7c) El nen va portar cada gallina al seu corral.
the child PAST take each hen to-the her poultry

No such asymmetry in distribution is found, to our knowledge, with *tots* (see (8)), and we test the interpretation of *tots* in both positions: subject and object position.

(8a) Tots els nens van portar berenar.
All-pl the children PAST bring tea
(8b) Un nen va portar tots els berenars.
A child PAST bring all-pl the teas

3 The experiment

3.1 Subjects

The subjects who took part in our experiment were 35 Catalan-speaking children in a kindergarten and primary school, with a mean age of 5;3. In order to be able to draw generalisations about the developmental stages our subjects go through, and given the number of children tested for each age, we grouped 3- and 4-year olds in group 1 (three 3-year-olds, sixteen 4-year-olds), and 5-, 6- and 7-year olds in group 2 (six 5-year-olds, four 6-year-olds, seven 7-year-olds).

Table 1. Subjects

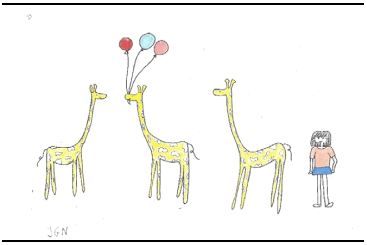
age group	age	age range	#
G1	3, 4	3;5–4;9	19
G2	5, 6, 7	5;0–7;11	17
total			35

3.2 Design

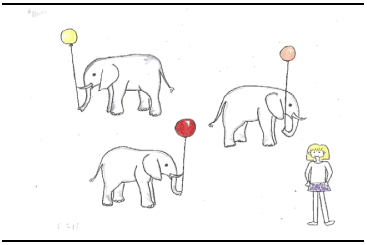
The conditions tested fall into five categories, corresponding to an input with the universal quantifier in object position (QO) or in subject position (QS), both of them getting an affirmative (J) or negative (N) answer in the target language. (See the full relation in the Appendix.) An affirmative answer to the input QS N constitutes an underexhaustive error. The fifth condition (QSX J) presents the quantifier in subject position and gets an affirmative answer in the target language but, if the overhaustive error occurs, gets a negative answer. The pictures appearing on each condition are exemplified in (9) to (13):

(9) Una girafa porta tots els globus?
('Is a giraffe carrying all the balloons?')
Adult response: Yes

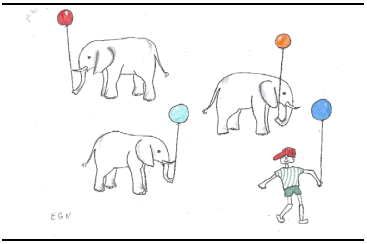
QO J



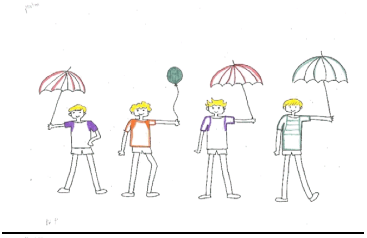
(10) Un elefant porta tots els globus?
('Is an elephant carrying all the balloons?')
Adult response: No
QO N



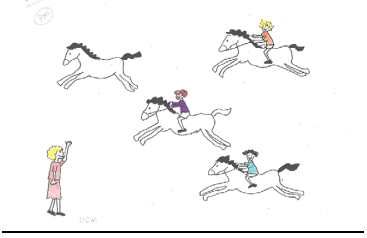
(11) Tots els elefants porten un globus?
('Are all the elephants carrying a balloon?')
Adult response: Yes
QS J



(12) Tots els nens porten un paraigües?
('Are all the children carrying an umbrella?')
Adult response: No
QS N



(13) Tots els nens munten a cavall?
('Are all the children riding a horse?')
Adult response: Yes
QSX



This design rests primarily on the work of Philip (1995), although its results turn out to be only partially interpretable under his theoretical stances.[2]

2 This experimental design was called into question by Crain et al. (1996) on the grounds that the task is problematic from a pragmatic point of view; however, as discussed by Gordon (1996), the arguments of Crain et al. (1996) are inconclusive.

3.3 Method

Each child was tested individually, in a school setting that was relatively free of distraction, by two experimenters who were native speakers of Catalan. The experiment was preceded by a single warm-up item, to confirm that the experimental task was well understood and to familiarise the child with the characters and objects in the pictures. The experiment was a truth conditional task, where children were asked to answer a yes/no question about a picture they were shown. Each question involved one of the conditions previously discussed.

Each child was presented a total of 13 experimental items presented in a pseudo-random (maximally varied) order. Each item consisted of a 21 x 29 cm colour picture. The objects in the picture were distributed in a thematically neutral fashion, and were presented to the child by Experimenter 1 in context-sentences such as *Hi ha tres globus i tres nens* ('(In this picture) there are three balloons and three children'). After each context-sentence, the child was asked the experimental yes/no question about the picture; this question was formulated by Experimenter 2, who could not see the picture. This made the question felicitous as a request of information – basically, the experiment was construed as a guessing game. (This avoids the putative methodological problem which Brinkmann [1995: 11] attributed to Philip [1995].)

In order to see the source of possible errors in interpretation, children were also asked to reason their answers with respect to those pictures containing an intruder. In each case, children were given the opportunity to point at the non-paired individual.

As the experiment was presented together with another experiment on referentiality, a large number of fillers were granted.

4 Results

Our results are reported in Table 2. No children were excluded as it was our intention to see what their behaviour was before establishing further a priori conditions. It is worth pointing out that, of the children who took part in our experiment, 20% had a fully adult-like behaviour (error-free); this raised to 57% of 7-year-olds. Performance was very accurate for all age groups except in the QSN and the QSXJ conditions.

condition	G1	G2
QS J	78%	88%
QS N	56%	94%
QSX J	72%	59%
QO J	94%	94%
QO N	94%	100%

Table 2: Percentage of correct answers

Unsurprisingly, consideration of the standard deviation of the results in Table 2 indicates high variation amongst individuals for the conditions QSN (for the younger group) and QSXJ, as shown in Table 3:

condition	G1	G2
QS J	0.43	0.33
QS N	0.51	0.24
QSX J	0.46	0.51
QO J	0.24	0.24
QO N	0.24	0.00

Table 3: Standard deviation

We performed a series of t-tests on the results of the experiment to see when the differences between the two age groups reached significance, and we only found a significant difference for the QSN condition, in which the older children performed significantly better than the younger ($p = 0.000$).

On the other hand, the incidence of overexhaustive errors (in the QSXJ condition) is relatively high, and general for the two age groups considered.

5 Discussion

These results do not differ dramatically from those obtained in a similar experiment carried out with Spanish-speaking children by Escobar, Baauw and Philip (1997): for 45 children with a mean age of 5;6, they obtained the following results:

condition	percentage correct
QS N	74%
QSX J	78%
QO J	90%
QO N	89%

Table 4: Results for Spanish

These results are to be compared with the means for our two groups (mean age: 5;3, comparable to the mean age of the Spanish-speaking children: 5;6): 75% on the QSN condition, 65.5% on the QSXJ condition, 94% on the QOJ condition and 97% on the QON condition. The asymmetry in the comprehension of sentences with quantifiers in subject position and object position found here and in the experiment of Escobar, Baauw and Philips has also been found by Escobar and Torrens (2008). In that paper, Escobar and Torrens manipulated the position of the subject, which can be either pre- or postverbal, and the position of the subject did not affect the level of comprehension: what affected comprehension was the presence of an extra entity, i.e. the existence of an unpaired entity, which rendered comprehension more difficult and gave rise to under- and overexhaustive interpretation.

To account for the impact of such unpaired entities in comprehension, Philip (1995) proposes to interpret overexhaustive search according to an "event quantificational account". For him, a sentence such as *Every boy is riding a horse* can be interpreted by the child as 'In every minimal event/situation in which a boy is participating or which is a possible subevent of a minimal event/situation of a boy riding a horse, a boy is riding a horse'. Since in the setting depicted in (13) and schematised in (14) we encounter a possible subevent of a minimal event/situation (with the presence of $horse_4$), when asked if all the boys ride a horse the child may answer negatively.

(14) boy_1 rides $horse_1$
boy_2 rides $horse_2$
boy_3 rides $horse_3$
$mother_1$
$horse_4$

This is termed "symmetrical interpretation". This is the result, in the child, of an "overgeneralisation of an adult event quantificational interpretation – which in adult grammar is normally only associated with adverbs of quantification such as *always*" (Philip, 1996). From the availability to the child of a symmetrical interpretation and the standard quantificational reading in the acquisition of distributive universal quantifiers, a 50% correct answer pattern is predicted by Philip.

Our results are in line with Philip's (1995) predictions with regard to the QSX J condition, even more so if we take into account that over-

exhaustive errors seem to be more likely with *every* than with *all* (see Freeman and Stedmon, 1986).

It is also worth noting that a relatively high number of errors occurred with the younger group of children in the QS J condition, where children were asked *Are all the elephants carrying a baloon?*, and they answered correctly only in 78% of cases. This is the behaviour that corresponds to what Philip (1995) calls the "perfectionist child", who is meant to have a less mature procedure for the interpretation of quantification than the "symmetric child". For the perfectionist child, a boy carrying a balloon constitutes conflicting evidence for the assertion *All the elephants are carrying a balloon*.[3]

On the other hand, there is a highly significant fact in our results: the occurrence of underexhaustive search in nearly half of the cases in the QS N condition, although only for the 3- and 4-year olds. Underexhaustive errors are not accounted for by Philip (1995), on the grounds that they are unsystematic, although they have been argued to occur systematically by other authors (see Freeman, 1985; Drozd, 2001). Furthermore, it has been found for English that underexhaustive errors are more likely to occur with the universal quantifier *all* than with the distributive quantifier *every* (although this is not replicated in all experiments; cf. Philip, 1995). This disparity in behaviour between different quantifiers, if true, is unexpected in Philip's (1995) framework, as pointed out by Brinkmann (1995).

There appears to be no satisfactory analysis of all these facts. Recent developments may, however, enlighten our results and others in the literature. Kuznetsova et al. (2007) ran a picture selection task on the comprehension of Russian quantifiers, exemplified in (15a), and found symmetrical errors; moreover those errors carried over to sentences without the quantifiers, as in (15b):

(15a) Vse devočki djat moroženoe.
All girls eat ice-cream
'All the girls eat ice-cream.'

(15b) Mal'čiki strojat doma.
boys are.constructing houses
'The boys are building houses.'

3 Philip's (1995) account of the so-called perfectionist child has been called into question for lack of consistency with the event account proposed for symmetrical interpretation errors; we refer the reader to Brinkmann (1995).

The results of the experiment showed that children had a strong preference for the symmetrical responses when the quantifier was in subject position, but not in object position; yet this preference for symmetrical responses was also attested with subjects without quantifiers (unmodified plural subjects in their terms) – another instance of overexhaustive error.

In their study of an apparently unrelated issue, the German focus particle *nur* 'only', Müller et al. (2010) found that comprehension of the scope of the focus marker varied depending on whether it appeared on the subject or the object:

(16a) Nur die Ente hat ein Boot.
'Only the duck had a boat.'
(16b) Die Ente hat nur ein Boot.
'The duck had only a boat.'

In their results, 4-year-old German-speaking children perform worse than 6-year-olds in their comprehension of (16), but both at ages 4 and 6 they understand (16b) significantly better than they understand (16a).

To recapitulate, our pilot study shows the developmental stages that children go through in acquiring a fully adult-like interpretation of the universal quantifier *tots*: from an early stage with a relatively high incidence of underexhaustive errors (in the group of 3- and 4-year olds) to a later stage in which underexhaustive errors disappear, but overhaustive errors persist in many subjects. Any theoretical attempt at explaining these facts should be able to account for them while making the occurrence of one and the other independent. Recent work indicates that subject-object asymmetries in child interpretation are not restricted to the empirical domain of universal quantifiers: they are found in the interpretation of bare plural subject in Russian, and in the interpretation of focus scope in German. A more general account of all these facts is therefore called for.

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Appendix: Experimental items

QO N	Una girafa porta tots els globus? Is a giraffe carrying all the balloons?
QO N	Un nen porta tots els paraigües? Is a boy carrying all the umbrellas?
QO N	Un elefant porta tots els globus? Is an elephant carrying all the balloons?
QO N	Una girafa porta tots els globus? Is a giraffe carrying all the balloons?
QO J	Un nen porta tots els paraigües? Is a boy carrying all the umbrellas?
QO J	Un elefant porta tots els globus? Is an elephant carrying all the balloons?
QS N	Tots els nens porten un paraigües? Are all the children carrying an umbrella?
QS N	Tots els nens beuen una llimonada? Are all the children drinking a lemonade?
QS N	Tots els dinosaures porten un globus? Are all the dinosaurs carrying a balloon?
QS J	Tots els elefants porten un globus? Are all the elephants carrying a balloon?
QS J	Totes les girafes porten un globus? Are all the giraffes carrying a balloon?
QSX J	Tots els nens munten a cavall? Are all the children riding a horse?
QSX J	Tots els nens munten un elefant? Are all the children riding an elephant?

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Resum: És ben sabut que els nens interpreten els quantificadors universals d'una forma diferent que els adults, com ja van mostrar Inhelder i Piaget; en aquest article presentem els primers resultats experimentals de la interpretació del quantificador universal tots en català, en nens de 3 a 7 anys. Observem que en un primer estadi (als 3 i 4 anys) incorren en errors subexhaustius i superexhaustius; els primers desapareixen en el període següent (als 5 anys), mentre que els errors superexhaustius persisteixen durant tot el període examinat. Adduïm, a més, que hi ha evidència en altres llengües que mostra que l'asimetria entre subjectes i objectes subjacent a aquest tipus d'errors no només afecta els quantificadors.

Summary: Since the work of Inhelder and Piaget, children have been known to interpret universal quantifiers differently from adults; in this paper we present the first experimental results on the interpretation of the universal quantifier *tots* 'all' by speakers of Catalan aged 3 to 7. We observe an early stage (ages 3 to 4) in which children incur in underexhaustive and overexhaustive errors; while the first disappear at a later stage (at age 5), overexhaustive errors persist all through the period examined. Further, cross-linguistic evidence can be adduced to show that the asymmetry between subject and object underlying this kind of errors extends beyond the empirical domain of quantifiers. [Keywords: Acquisition; universal quantifiers; Catalan; overexhaustive search; underexhaustive search]